

A Lighting Transformation

2012 DOE Solid-State Lighting R&D Workshop

Josh Baribeau

1/31/2011

Agenda

- Who we are
- The energy dilemma
- The Second & Third Cycles
- Reducing ASP through subsidies
- Reducing costs with throughput and yield
- Beyond the myopic solutions
- Summary



Full Service Platform

BREADTH OF PRODUCTS & SERVICES

- Corporate Finance
 - Initial public offerings
 - Follow-on/secondary offerings
 - Public venture capital
 - Private placements & PIPEs
 - Convertible securities
 - Structured finance
 - Fixed income
- Advisory
 - Mergers & acquisitions
 - Divestitures
 - Restructuring
- Research
- Sales & Trading
 - Equities
 - Debt

DEEP INDUSTRY KNOWLEDGE ACROSS SECTORS

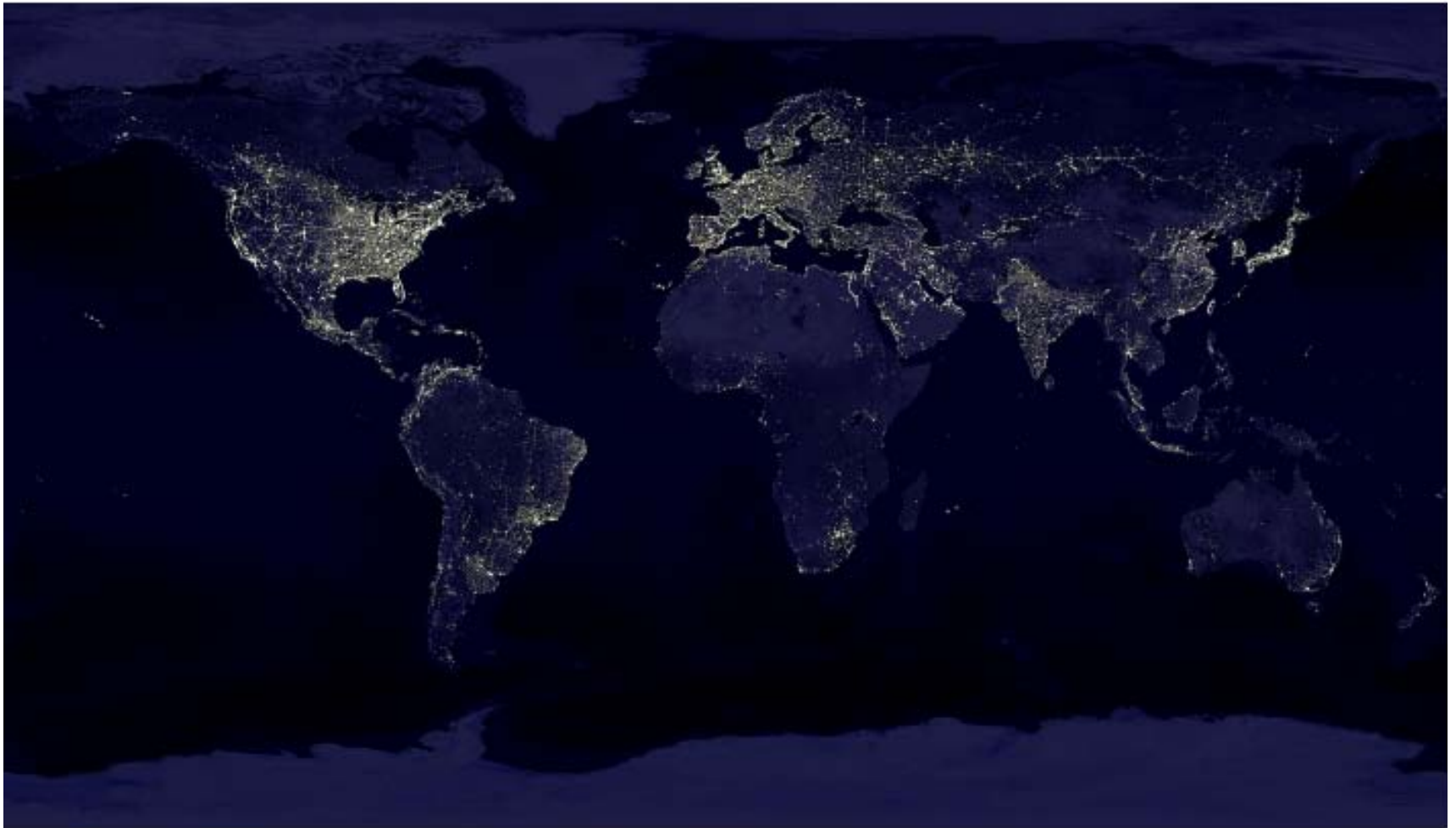


EXPERTISE ACROSS MARKETS



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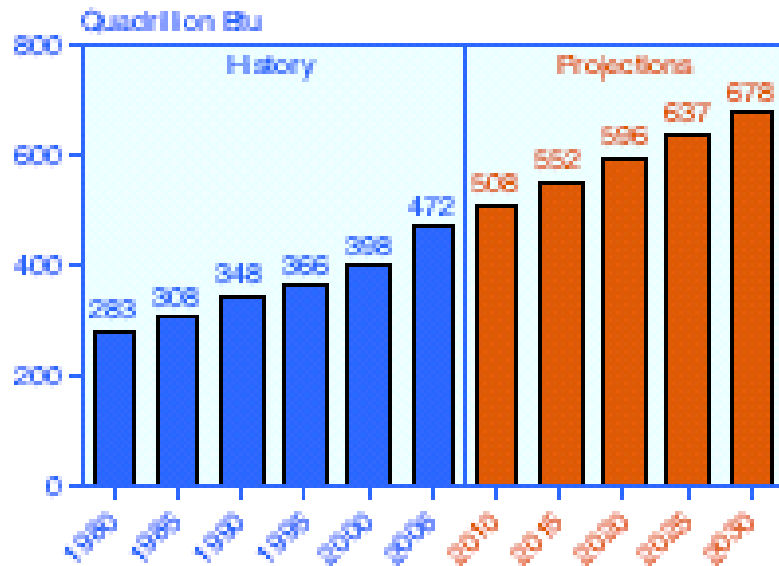
The Energy Dilemma



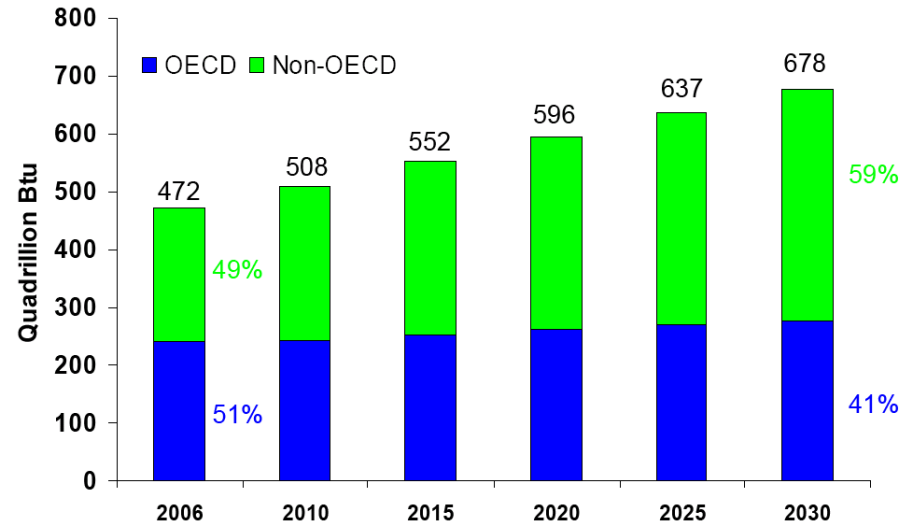
Photograph: NASA

Energy – Demand

Worldwide Energy Consumption

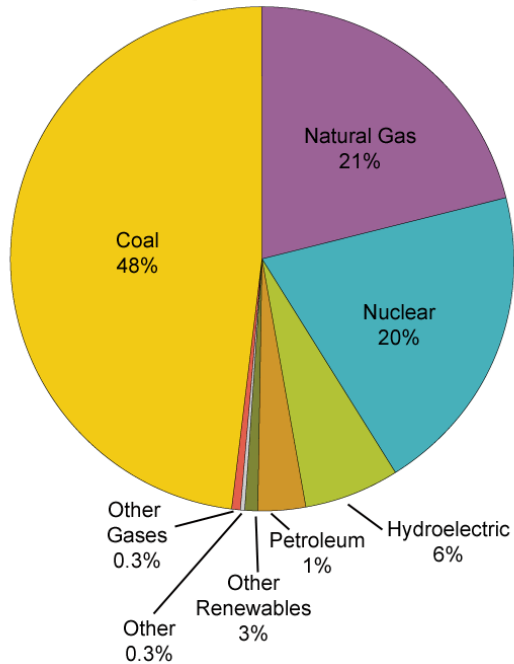


Non-OECD countries account for 82% of the increase in global energy use

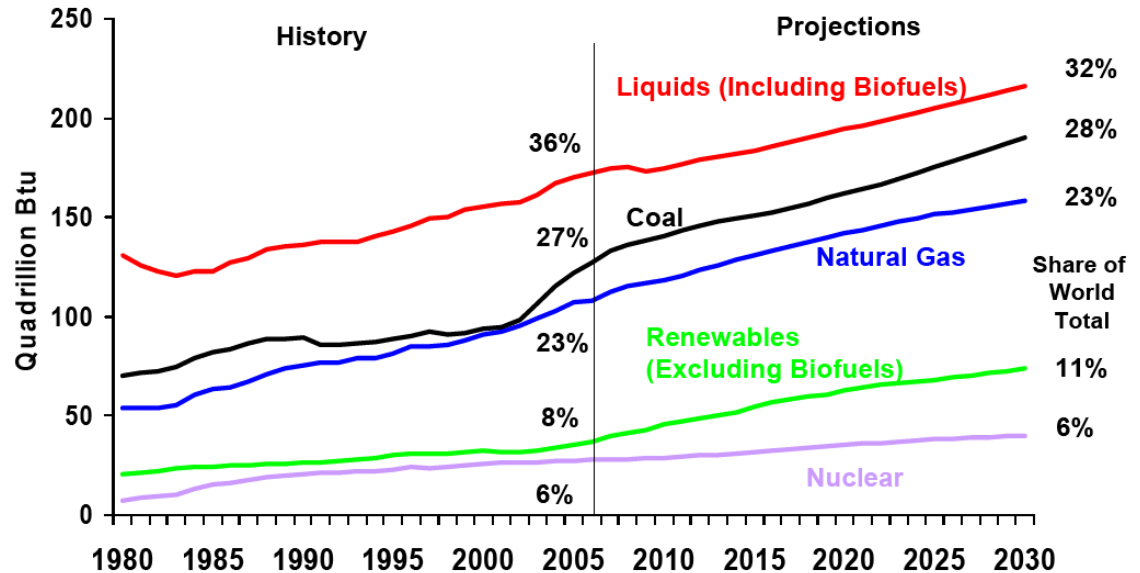


Energy - Supply

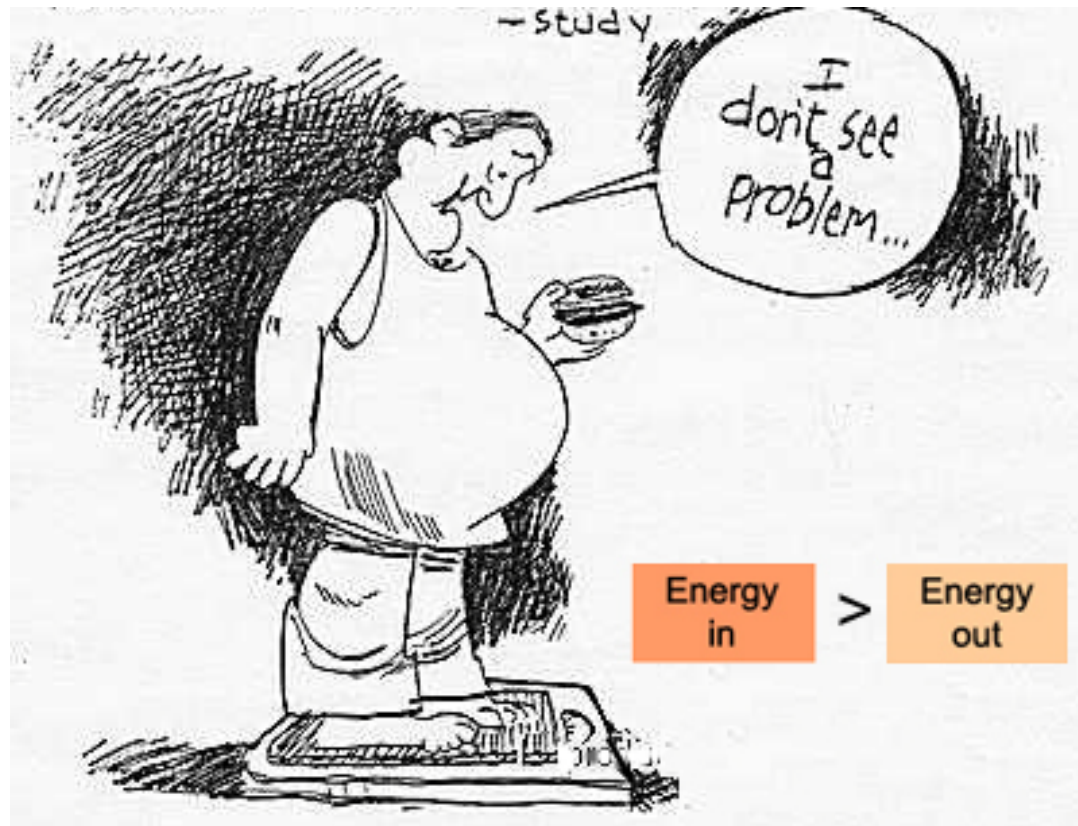
U.S. Electric Power Industry Net Generation by Fuel, 2008



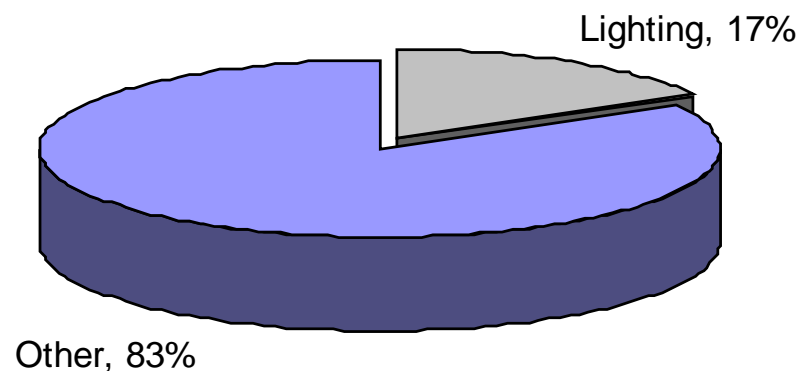
Renewables are the fastest growing energy source



The World Needs to go on An Energy Diet



Worldwide Electricity Consumption



2010: 17,800 Terawatt hours total electricity consumption,
3,000 TWH was for lighting

The Second Cycle

First ever bottom up MOCVD reactor supply model

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Sustainability -- Energy & Power Technologies

The Second Cycle

Worldwide LED supply/demand analysis and technology primer

- Our base case supply/demand scenario highlights that LED manufacturing capacity is quickly heading for a significant shortage around 2010. We conclude that meeting the projected demand will require between 800 and 650 high-capacity MOCVD reactors worth \$650 million to \$1.4 billion. As such, we see the current cycle as a bullish indicator for both of the incumbent equipment suppliers.
- Our prediction of a capacity shortage is driven by a 20% CAGR forecast in total LED demand through 2012, resulting in projected revenue ranging from \$15.8 billion to \$24 billion. The largest drivers of this demand forecast are notebook and LCD TV backlighting, which we expect to go to 95-100% penetration and to 20%-50% penetration by 2012, respectively. We predict general lighting will represent the next wave of LED growth, at only 10%-18% of total LED revenues in 2012.
- Our analysis concludes yield losses at the reactor and packaging levels are well below optimal, suggesting further vertical integration between epi, chip, and package companies in an attempt to bring up yields, as well as a renewed focus on manufacturing techniques in an effort to drive down costs.
- We see the Chinese market as very large, yet almost impossible to quantify in terms of actual demand. China presents a critical sales channel for many non-Chinese LED suppliers as an outlet for the large quantities of "off spec" die from the poor yields mentioned above. This market is likely to be increasingly served by domestic Chinese manufacturers as they climb the learning curve in LED capacity and manufacturing processes, placing greater emphasis on distribution schemes and pressuring margins.
- New entrants such as Samsung and LG Electronics should bring greater scale and manufacturing expertise from traditional semiconductor markets. However, it is too soon to be certain how successful and what yields these companies will achieve, and what the implications are for the industry's supply/demand balance.

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7 July 2009 2009-102

The Third Cycle

Complete proprietary bottoms-up assessment of overall lighting industry & True CoO model for LED penetration over hundreds of scenarios to 2020



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Sustainability -- Energy & Power Technologies

The Third Cycle

Quantifying the lighting market and implications for the LED supply chain



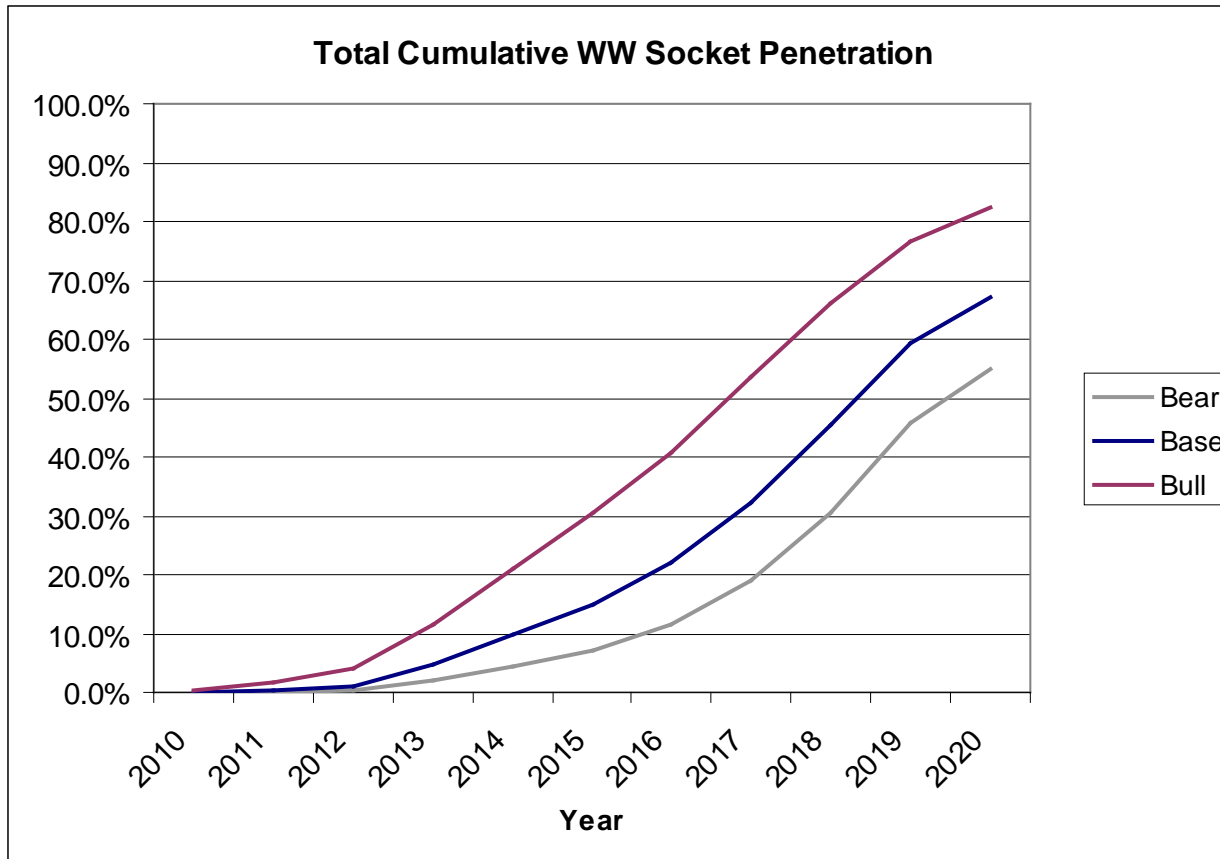
Source: Lumenore Fine Arts

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- We believe *The Third Cycle* will become the gold standard to measure the adoption of solid state lighting (SSL) over the next decade, as *The Second Cycle* was to the current BLU investment cycle. We find the greatest misconception is the notion that the residential market represents the entire lighting opportunity. This report should help clear up confusion.
- Our extensive models based on anticipated paybacks, price points, demand elasticity, etc., predict that that LED lighting will reach a cumulative penetration of between 32.3% and 60.3% of the global lighting market by 2020, for cumulative LED revenues of between \$105.9B and \$313.8B.
- We conclude that LEDs will save a cumulative 5T kWh of electricity in the next decade, removing the need for 55@ full-sized power plants from the grid and reducing a cumulative 8.4B tons of CO₂ emissions from the atmosphere, equal to the emissions from all of the passenger cars in the world.
- Achieving 48% penetration of the worldwide lighting market would create 1.3M jobs and result in cumulative energy savings of over \$489B over the next decade, making it one of the most important trends for investors and all of us.
- We predict the need for between 6,300 and 4,700 additional MCCVD tools to be installed in the next decade to meet demand. Further, we calculate the need for the sapphire market to grow to over \$2B by 2020 up from \$200M last year.
- Our investment strategy is multifaceted. We continue to "own" the bottlenecks as

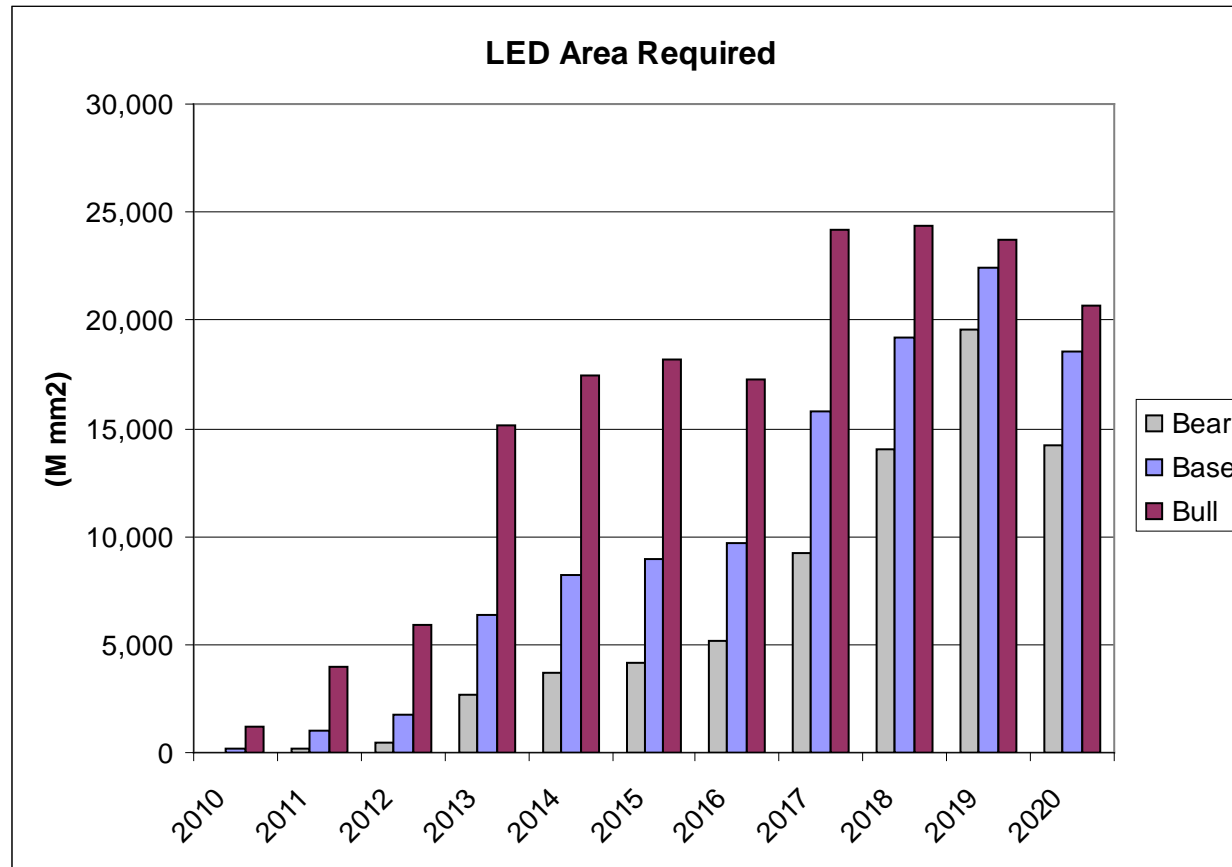
Adoption Curves – Cumulative

- 54.8% to 82.5% by 2020



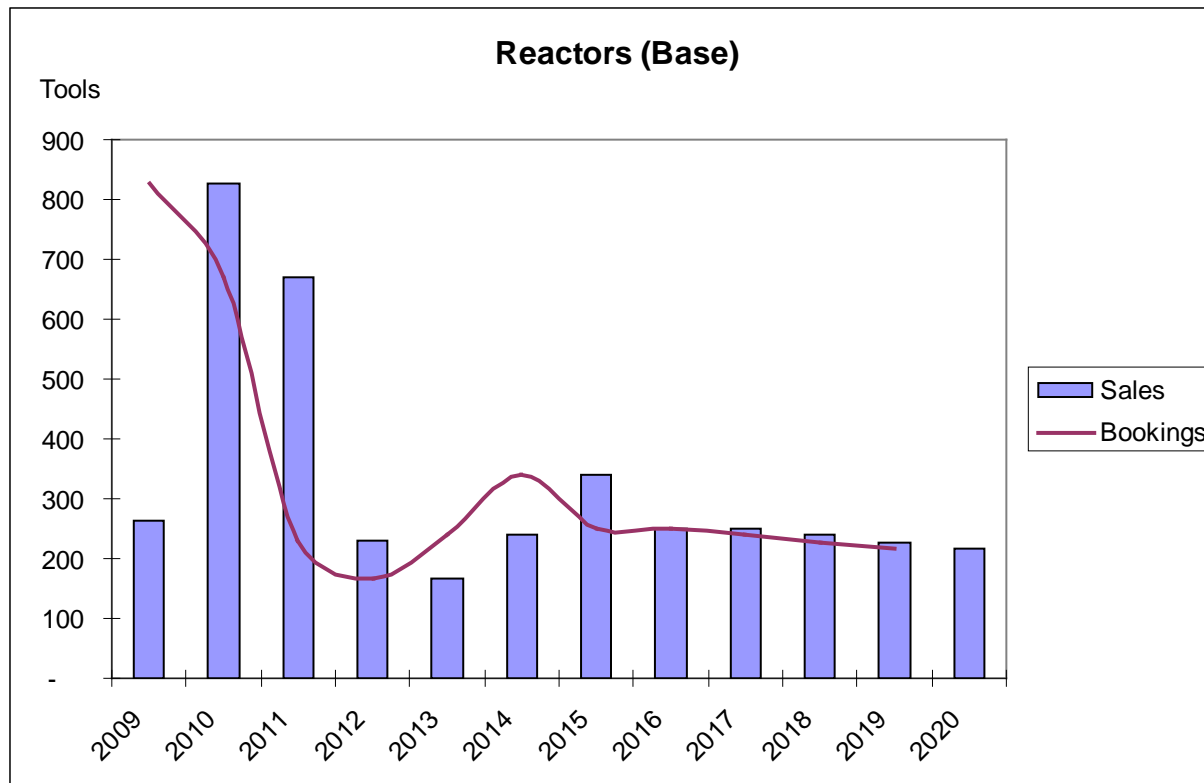
Adoption Curves – Cumulative

- 258.8B and 385.0B mm² of yielded, packaged epi between 2012 and 2020

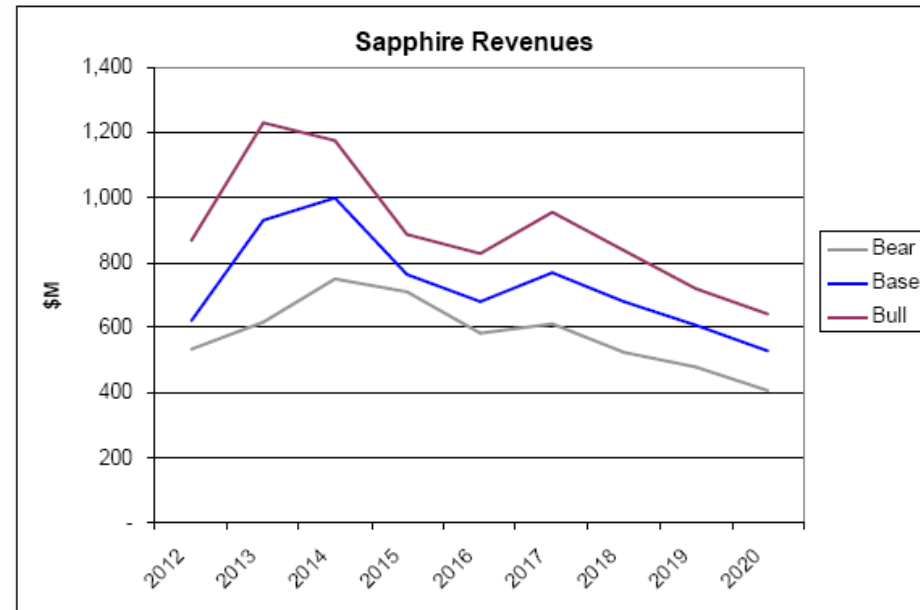
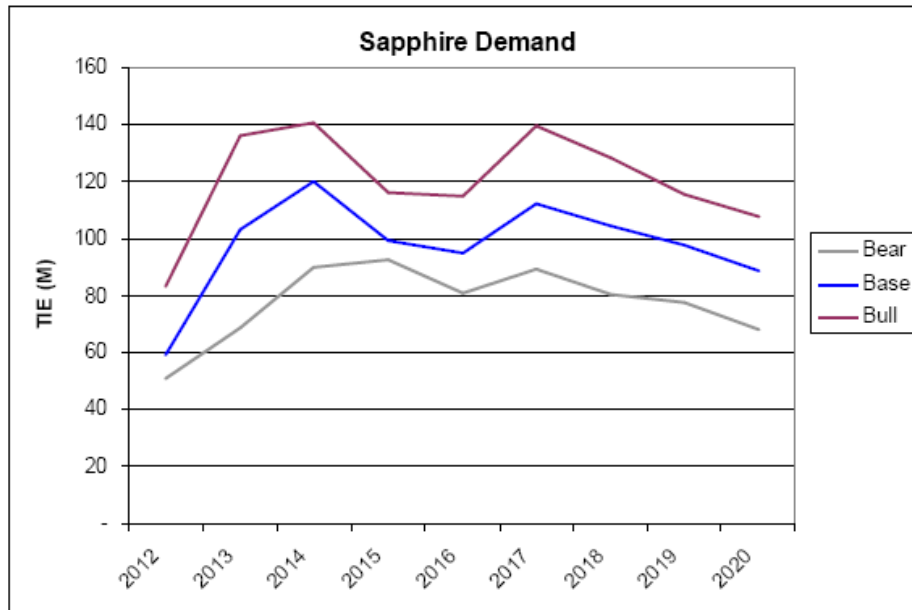


MOCVD

- 2,900 to 4,800 tools projected from 2010-2020
~300 average per year
- Where is the Third Cycle?
- Replacement/Upgrade/COO



Sapphire Supply-Demand



So how do we get there?

“Ban the Bulb”

	2010	2011	2012	2013	2014
USA			100W	75W	60W - 40W
Canada			100W (Deferred)	75W (Deferred)	60W - 40W (Deferred)
Mexico			100W	75W	60W - 40W
China			100W		60W
Cuba	Banned				
Argentina		Banned			
European Union	100W	75W	60W	40W - 15W	Banned
UK	100W - 75W	60W	40W - 15W	Banned	
South Korea			Banned		
Japan			Banned		
Philippines	Banned				
Malaysia	100W	75W	60W	40W	
Australia	Banned				

US Utility Rebates

- 138 program sponsors
- 423 individual incentives (CFL, Fluorescent & LED)
- 39% are manufacturer buy-downs
- 19% are LED; 50% are bulbs, 50% fixtures
 - with an average of \$12.50 instant savings

“Bill Hamilton of The Home Depot observed that LED products already account for nearly **10 percent of his company's retail light bulb business** in those regions where there are utility rebates to offset the initial cost”

– Jim Brodrick 7/21/2011

Full list at: http://www.energystar.gov/index.cfm?fuseaction=activity_search.basic

China

- All eyes on 12th 5-year plan
- Plan being written, nothing published yet
 - Multiple rumors, nothing definitive
- Our view:
 - Downstream subsidy
 - Focus on local producers
 - Overall positive for SSL, but implementation likely procrastinated



- Eco Points program
 - 4/2009: “points” for energy saving TVs, appliances, lighting; redeemable for other goods as an economic stimulus/green initiative
 - 12/2009: LED replacement bulbs added as redeemable product
 - By June 2010 LED bulbs were 19% of bulb volumes (60% of bulb value)
- Tsunami/Fukushima Dai-ichi disaster
 - Took 7% of Japan’s capacity offline
 - Sense of nationalism led to surge in LED bulb sales
 - LED bulbs briefly surpassed traditional bulbs
 - Has since cooled off – next wave likely spring cleaning

Korea

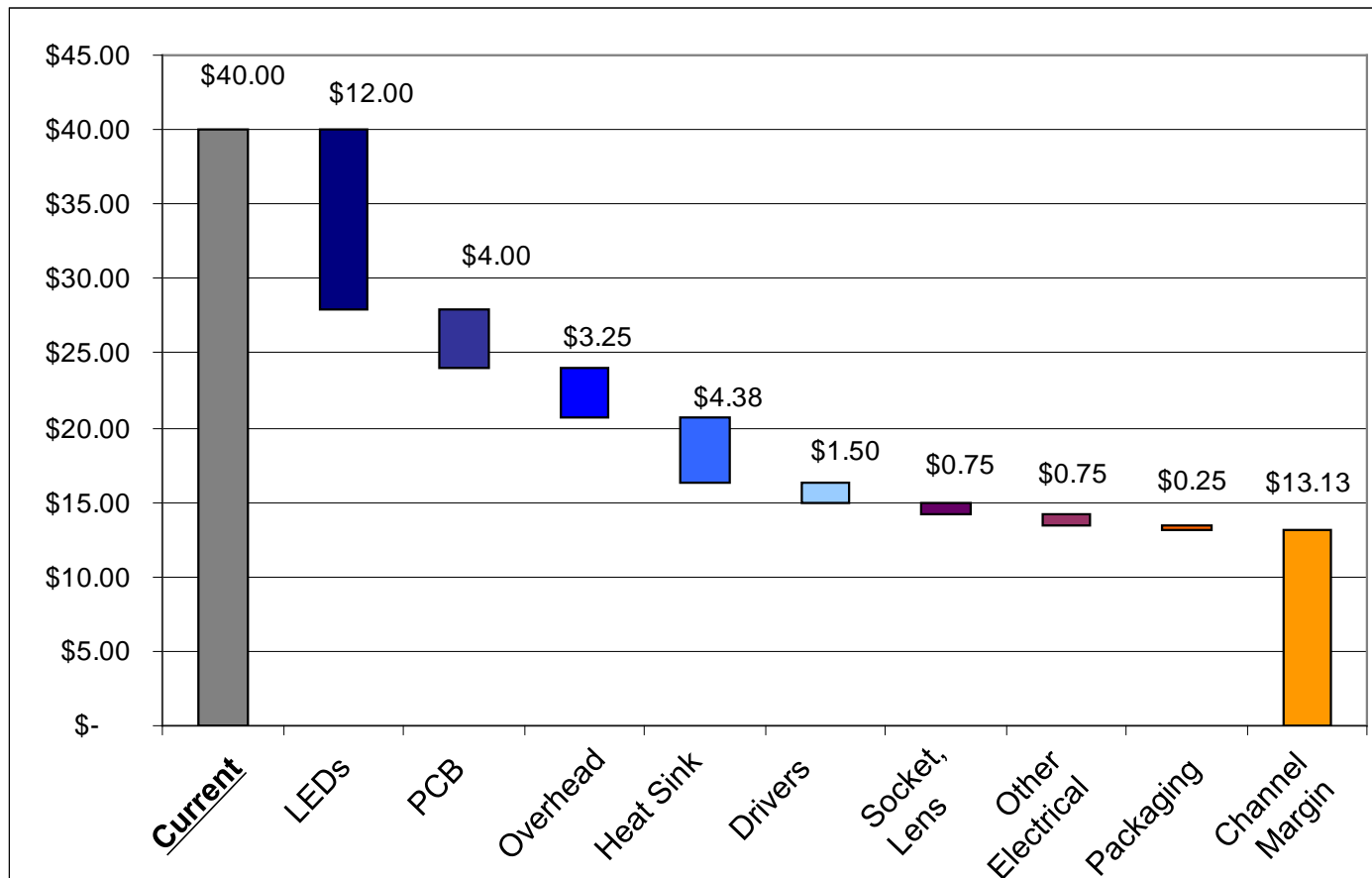
- Goal for 60% of all lighting to be LED by 2020
 - 100% in the public sector
- \$185M spent between 2012 and 2013 for public sector conversion, subsidies to small merchants and tax breaks to private Cos
- Presidential committee believes it can create a 1 trillion Won market and save 7-8 power plants



Reducing costs with throughput and yield

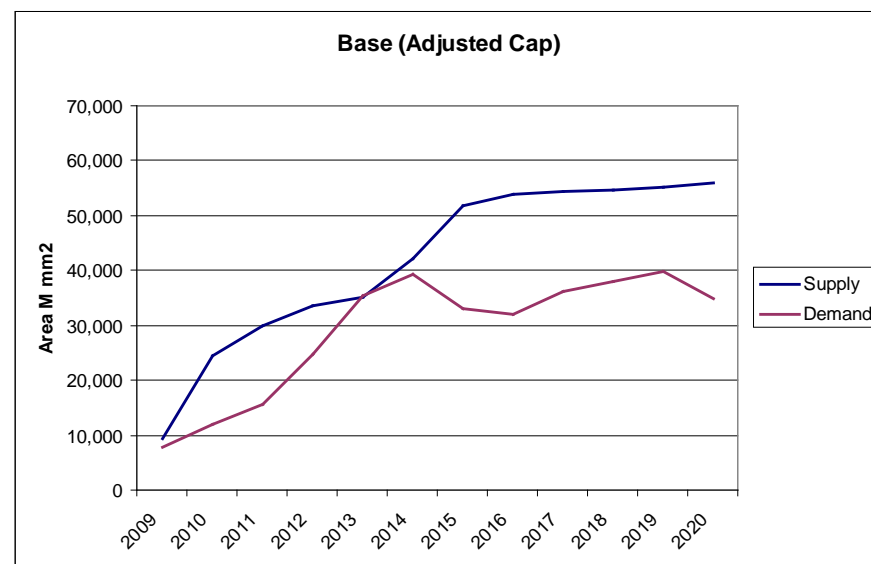
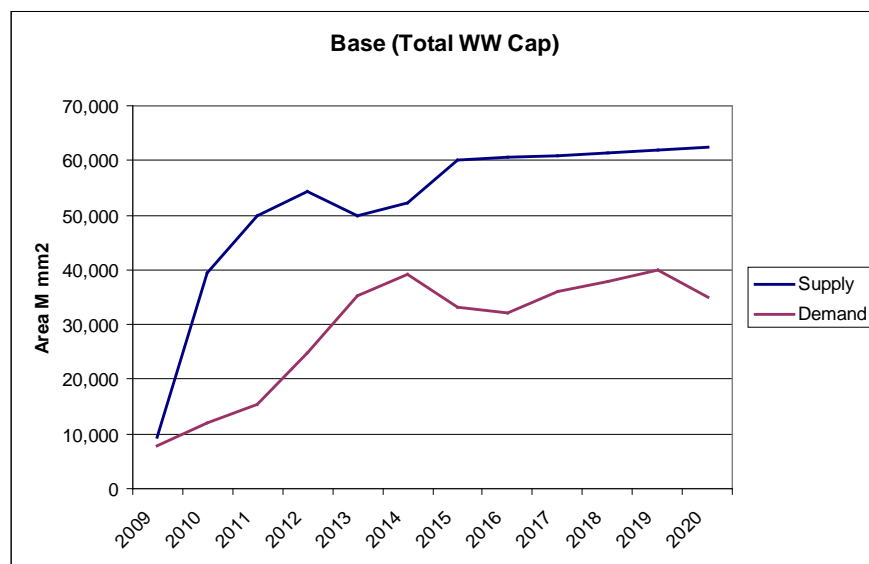
\$40 to \$4 how does this happen?

60W LED Lamp Bill of Materials



Projected LED supply-demand

- 200% growth in supply and 90% growth in demand from 2009-2011
 - Oversupply could commoditize the market, spur new wave of LED adoption
- Flattening of LED demand
 - Growing OLED penetration in trad. LED markets, gradual lighting adoption, improvements in LED efficacy



Analysis

- Oversupply leads to commoditization in many segments of the value chain.
- Cost structure becomes paramount in a commoditized environment.



Equipment

Substrate

Epi/Chip

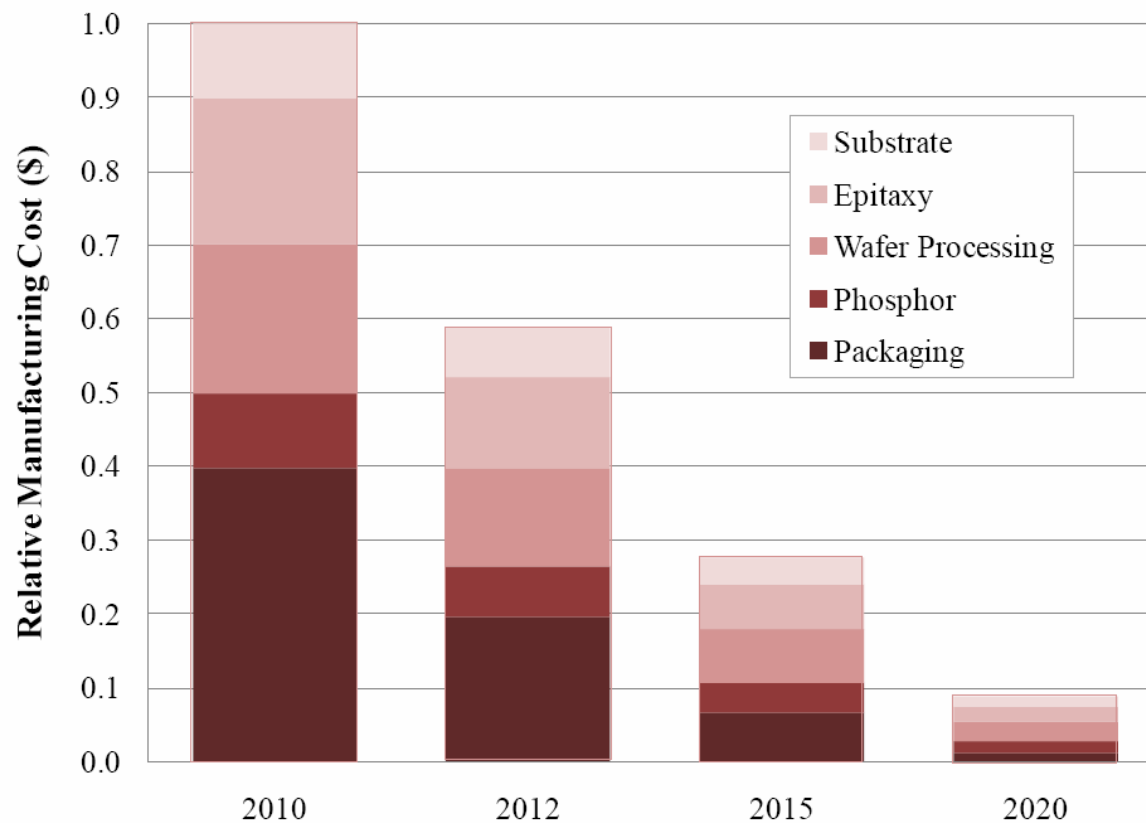
Package

Light Engine

Luminaire

Analysis

- DOE Cost Reduction Roadmap

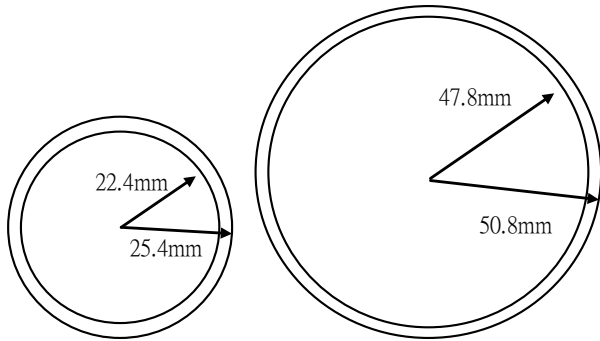


Throughput: Epi (MOCVD), Chip, Package

- Usable surface area per wafer increases
- Surface area per run increases

2" (50mm)

4" (100mm)



$r = 22.4\text{mm}$

$a = 1576\text{mm}^2$

$r = 47.8\text{mm}$

$a = 7178\text{mm}^2$ = 4.6x greater

	<u>42x2</u>	<u>11x4</u>	<u>6x6</u>
one wafer area (cm ²)	20	81	182
total wafer area (cm ²)	851	892	1094
change		105%	129%
one wafer usable area (cm ²)	16	72	168
total useable area (cm ²)	662	790	1010
change		119%	153%

Yield vs. throughput – gross margin sensitivity

- “Yield trumps all”
 - 10% improvement in yield is far more beneficial than a 10% improvement in throughput.

4-chamber

		Epi Yield			
Cycle time		55%	65%	75%	85%
	5.5	27%	38%	47%	56%
	6.0	26%	37%	46%	55%
	6.5	25%	36%	45%	54%
	7.0	23%	35%	44%	53%

2 chamber

		Epi Yield			
Cycle time		55%	65%	75%	85%
	5.5	21%	35%	43%	50%
	6.0	19%	33%	41%	48%
	6.5	17%	31%	39%	46%
	7.0	15%	29%	37%	44%

Yield: Epi (MOCVD), Chip, Package

- Yield stacking
 - Epi: <30% - 90%
 - Chip: 50 – 90%
 - Package: 65% - 90%
 - = 10% - 80% combined!
- Memory/Logic market >95%
- Much room for improvement

Beyond the myopic solutions

From efficiency...



2007: Lexus LS 600h first car to use LED daytime running lights
=1mpg savings!

...to Branding



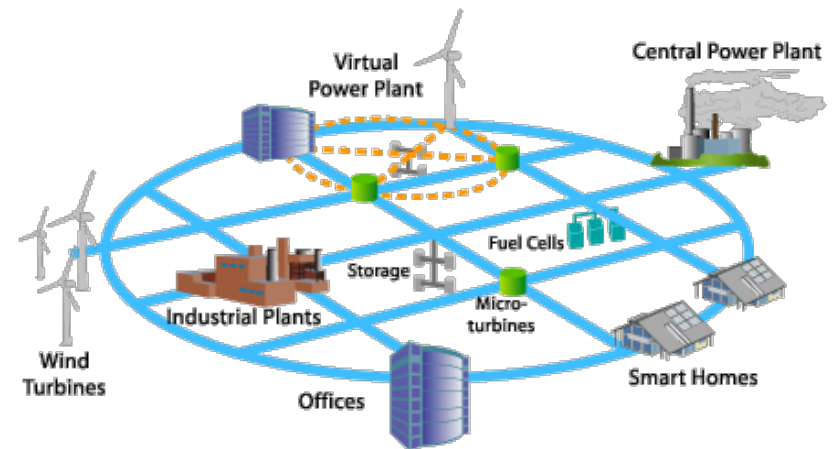
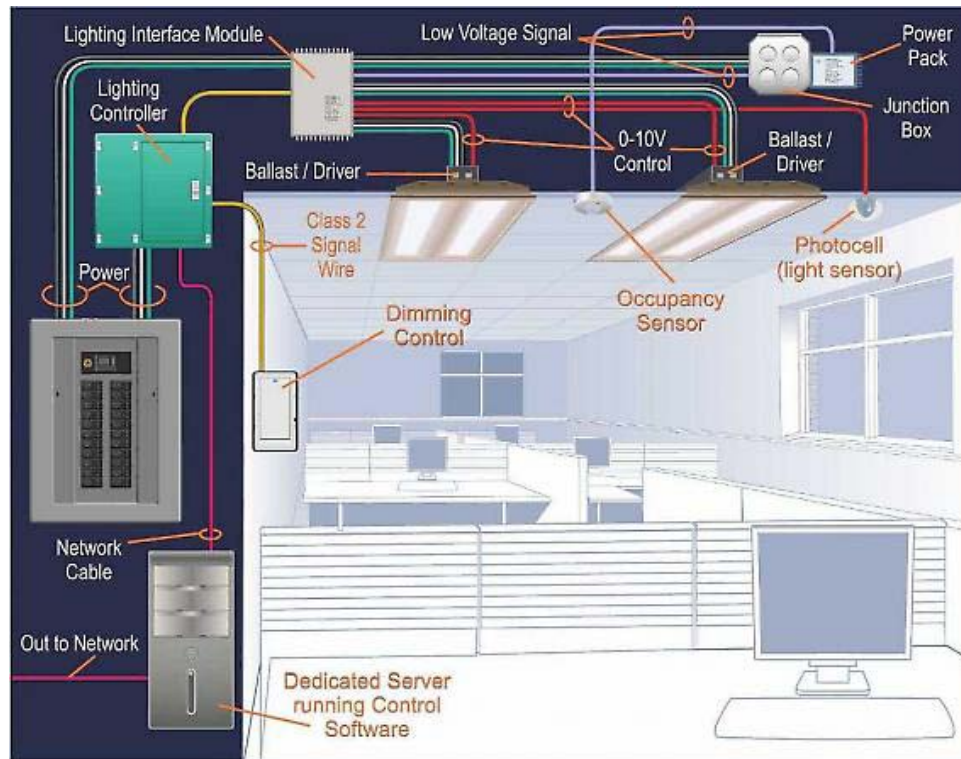
Today we recognize Audi in our rear view mirrors by the headlights

From efficiency...



Today it's all about instant energy savings

...to information



In the future most lighting could be networked, leading to greater insight into our energy consumption patterns and optimized electricity generation/distribution

The Agency Problem

- Many different commercial lease structures
- For example
 - Single net lease: tenant pays (1) property tax
 - Double net lease: tenant pays (1) tax and (2) insurance
 - Triple net lease: (1) tenant pays taxes, (2) insurance, (3) common area maintenance
- The Issue:
 - Who pays for the physical lighting upgrade may not be the one that benefits from the actual electricity savings...
- Where is the incentive?

Conclusions

- LED will be the “hidden gem” of the Cleantech/Sustainability movement
- Upstream investments have been made
 - Allows for costs to come down exponentially
- Government incentives will help but not required
 - Standards might be better
- LEDs will begin as an energy efficiency story
 - Blubs to fixtures
 - As in all other applications of LEDs transformation will occur beyond energy savings
 - Increased TAM
- Downstream innovation key

Thank you!

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Distribution of Ratings: Global Stock Ratings as of 4 January 2012

Coverage Universe		IB Clients	
Rating	#	%	%
Buy	481	60.7%	36.2%
Speculative Buy	92	11.6%	69.6%
Hold	205	25.9%	21.0%
Sell	14	1.8%	14.3%
	792	100%	

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